Systematic Review Article

Clinical parameters in soft tissue adjunctive periodontal procedures for orthodontic patients: surgical laser vs scalpel - *A systematic review*

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ABSTRACT

Objectives: To systematically review existing literature regarding clinical parameters comparing surgical laser and conventional surgery with scalpel for soft tissue adjunctive periodontal procedures in orthodontic patients.

Methods and Materials: MEDLINE, Scopus, Web of Science, The Cochrane Library, LILACS, Bibliografia Brasileira de Odontologia (Brazilian Dental Literature - BBO), Embase, Open Grey, Portal de Periódicos da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Coordination for the Improvement of Higher Education Personnel - CAPES), and Google Scholar were searched up to December 2020 without language restriction. Clinical trials comparing clinical parameters from surgical laser and conventional surgery with scalpel for soft tissue adjunctive periodontal procedures in orthodontic patients were selected. Risk of bias (RoB) assessments were performed using the Cochrane RoB2 tool. Narrative syntheses were performed, and the certainty of evidence was determined using the GRADE tool.

Results: Five randomized clinical trials were included. One study was rated as low RoB, whereas others presented some concerns or high RoB. The studies were highly heterogeneous in relation to the procedure performed, laser protocol, outcomes evaluated, and follow-up periods. In general, regardless of the procedure and laser protocol used, the studies did not show significant differences between laser and scalpel for the outcomes of probing pocket depth, clinical crown length, gingival index, and relapse rate. Pain and bleeding were significantly lower with the use of laser compared with the scalpel. The certainty of evidence ranged from moderate to very low.

Conclusions: The existing literature on the subject is scarce and very heterogeneous and has methodological limitations. Based on the available evidence, it is not possible to draw definitive conclusions about the beneficial effect of laser use in orthodontic patients. (*Angle Orthod.* 2022;92:265–274.)

KEY WORDS: Oral surgical procedures; Oral surgery; Orthodontics; Lasers; Laser therapy; Systematic review

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INTRODUCTION

The presence of fixed appliances on the teeth of orthodontic patients may lead to plaque accumulation, which can hamper oral hygiene, cause a shift in the microbial ecosystem, and result in the colonization of periodontopathic bacteria and gingival enlargement.[1] Gingival enlargement impedes the maintenance of good oral hygiene and only the removal of the harmful substances can provide healing of the periodontal tissues.[2]

Although the first step to treat these periodontal issues is a nonsurgical treatment (ie, oral hygiene instructions, scaling, and prophylaxis), this method is not always successful, especially when motivation and self-care are compromised.[3] Therefore, surgical approaches can be important tools to deal with periodontal issues. Conventional gingivectomy is performed with a scalpel and is considered the most common type of surgery.[4] Despite its ease of use and accuracy, it does not provide good hemostasis, which can be critical when treating inflamed tissues.[5] Surgical lasers, on the other hand, might be an alternative because they separate and coagulate simultaneously, providing better hemostasis, reducing the possibility of infection and preventing damage to hard tissues because their effect range is limited to soft tissues only.[6]

In addition to gingivectomy, different periodontal surgeries are routinely performed in orthodontic patients with fixed appliances, such as exposure of impacted teeth and circumferential supracrestal fiberotomy (CSF). CSF is a procedure used to reduce relapse of teeth after rotational movements and consists of transecting the supraalveolar (transseptal and free gingival) fibers of the periodontal ligament.[7] Similar to gingivectomy, the exposure of impacted teeth and CSF can also be performed conventionally with a scalpel or with surgical lasers.

A previous systematic review[8] already compared surgical periodontal procedures with scalpel and diode lasers; however, the review was not focused on orthodontic patients. Because orthodontic fixed appliances have already been proven to change the oral bacterial flora,[9] new answers are yet to be found. Thus, the present systematic review aimed to assess more extensively the existing literature to answer the following focused question: Are clinical parameters using surgical laser for soft tissue procedures in orthodontic patients with fixed orthodontic appliances better than using conventional surgery with a scalpel?

MATERIALS AND METHODS

This review was conducted with the guidance of the Cochrane Handbook for Systematic Reviews of Interventions[10] and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement.[11]

Eligibility Criteria

Studies meeting the following selection criteria were included:

- Participants: systemically healthy patients undergoing orthodontic treatment with brackets bonded to their teeth, with no sex, age, race, or malocclusion restrictions. Syndromic patients were excluded.
- Intervention: high-power laser used for soft tissue surgical adjunctive periodontal procedures, that is, surgical periodontal procedures in soft tissues that assist in the achievement of successful orthodontic treatment results.[12]
- Comparison: conventional use of scalpel for soft tissue surgical adjunctive periodontal procedures. Studies that involved hard tissues with unequal procedures between groups were excluded.
- Outcome: the primary outcomes were gingival index (GI), probing pocket depth (PPD), and bleeding assessment (BA). The secondary outcomes were pain assessment (PA), clinical crown length (CCL), and rotation relapse (RR).
- Study design: study designs were randomized and nonrandomized clinical trials. Case series, case reports, opinions from experts, reviews, and observational studies were excluded.

Information Sources, Search Strategy, and Study Selection

Systematic searches were performed in the following electronic databases: MEDLINE/PubMed, Scopus/Elsevier, Web of Science Core Collection/Web of Science, The Cochrane Library/Wiley, LILACS/Virtual Health Library, BBO/Virtual Health Library and Embase/Elsevier. Searches on gray literature were performed in Google Scholar (screening the first 200 results), OpenGrey, and Portal de Periódicos da CAPES. The search strategy was developed for PubMed and then adapted for the other databases according to their syntax rules (Table 1). No restrictions on date or language were applied.

After the removal of duplicates, titles and abstracts were read to screen the records by two independent review members (EOA Vargas and KM Magalhães). In case of disagreement between the two reviewers, a consensus meeting was held where a third review member participated in the final decision (G Marañón-Vásquez). When the abstracts did not provide enough information, full texts were retrieved for analysis.

Data Items and Extraction

The following data were extracted from the included studies: (a) author, year of publication, and country where the study was performed; (b) study design; (c) participant data; (d) intervention performed in the laser group; (e) intervention performed in the control group; (f) periods of evaluation; and (g) main study results and outcomes. When necessary, for 5 weeks, one email was sent weekly to authors for retrieving missing information. Two reviewers (EOA Vargas and KdM Magalhães) extracted the data from the articles independently, and a consensus meeting was held to compare the information collected. In cases of disagreement, a third reviewer (Dr Maia) joined the meeting and a decision was achieved.

Risk of Bias Assessment

An independent risk of bias (RoB) assessment was performed by two reviewers (EOA Vargas and KdM Magalhães) with the intervention of a third reviewer (Dr Maia) when disagreement occurred. The Cochrane Risk-of-Bias tool (RoB 2) was used to assess the RoB in randomized trials.[13] One email was sent weekly, for 5 weeks, to the authors to retrieve any missing data.

Synthesis Methods and Certainty of Evidence Assessment

Narrative syntheses were made for the results reported on each outcome and for each specific procedure performed. As pre-established in the protocol, a quantitative synthesis was planned depending on the clinical and/or methodological heterogeneity of the included studies. Random effects meta-analyses would be performed to estimate mean differences or standardized mean differences between laser and scalpel surgeries for the outcomes reported as continuous data (eg, PPD, CCL, RR, GI). For those outcomes reported as categorical data (eg, bleeding and pain), the relative risk for them in relation to the intervention received would be estimated.

The certainty of evidence was determined using the GRADEpro Guideline Development Tool.[14] The RoB, inconsistency, indirectness, imprecision, and other considerations (suspicion of publication bias) were the items considered to rate the overall certainty of evidence for the narrative syntheses.[15,16]

RESULTS

Study Selection

The flow chart of the search selection procedures, according to the PRISMA 2020 guideline,[11] is shown in Figure 1. Of the 796 articles initially retrieved, 494 remained after removing duplicates. A total 486 records were excluded after title and abstract screening, and eight articles were finally assessed for eligibility. Three articles were excluded after full-text reading (reasons for exclusion are shown in Figure 1). The alerts created in the databases revealed 30 new studies, none of which met the eligibility criteria. No extra references were added after contact with experts. In the end, five studies were included for qualitative synthesis.[4,17–20]

Study Characteristics

Three of the studies were performed in Iran,[17,19,20] one in Italy,[4] and one in Nigeria.[18] All studies were identified as randomized clinical trials.[4,17–20] Three studies evaluated gingivectomy,[4,17,18] two assessed CSF,[19,20] and one evaluated surgical exposure of impacted teeth, operculectomy, and frenectomy.[18] The sample size ranged from 12 to 38 participants. Three studies used diode lasers,[4,17,18] one used a chromium-sensitized garnet-yttrium-scandium-gallium crystal (Er.Cr:YSGG) laser[19] and another an erbium-doped yttrium aluminium garnet (Er:YAG) laser.[20] The following five different laser wavelengths were used: 810 nm[4], 2780 nm,[20] 940 nm,[17] 2940 nm,[19] and 810 nm.[18] Two surgical scalpel blades were used: 15C[4,17,18] and 11.[19,20] Three studies evaluated PPD and CCL.[4,19,20] One study evaluated GI,[4] two studies assessed RR,[19,20] and four studies assessed the pain experienced by patients.[17–20] Two studies evaluated BA.[17,18] Evaluation periods ranged from immediately after surgery to 1, 2, and 6 months (Table 2).

RoB Within Studies

The RoB assessment for randomized studies classified one of the studies as low risk.[4] There was a consideration regarding the domain related to bias in measurement of the outcomes, as requested by the RoB 2 tool.[13] Outcomes were assessed individually because, for some of them, calibration could have been previously performed (PPD, CCL, GI, and RR), but not for others (PA, BA). Hence, the study from Miresmæili et al.[20] was evaluated as having some concerns for PPD, CCL, and RR, and with high risk for PA (Pain assessment was judged as having high RoB). The study from Sobouti et al.[17] was judged as having some concerns for PPD, CL, and RR, and with high risk for PA. The last two studies were judged as high risk.[18,19] The main factors that contributed to the RoB were the lack of clarity/quality in the randomization processes and the fact that outcome assessors were aware of the interventions received by the patients (Figure 2). The answers from

Table 1. Search Strategies Used in Search Procedures

MEDLINE/Pubmed	SCOPUS	Web of Science	Cochrane
(Oral Surgical Procedures[Mesh] OR Procedure Maxillofacial[Tiab] OR Surgery, Oral[Mesh] OR Oral Surger*[Tiab] OR Maxillofacial Surgery[Tiab] OR Surgery[Tiab]) AND (Orthodontics[Mesh] OR Orthodontic*[Tiab]) AND (Lasers[Mesh] OR Laser Therapy[Mesh] OR Laser*[Tiab])	TITLE-ABS-KEY((“Oral Surgical Procedure” OR “Oral Surgical Procedures” OR “Procedure Maxillofacial” OR “Surgery Oral” OR “Oral Surgery” OR “Oral Surgeries” OR “Maxillofacial Surgery” OR Surgery) AND Orthodontic* AND (Laser* OR “Laser Therapy”))	((“Oral Surgical Procedure” OR “Oral Surgical Procedures” OR “Procedure Maxillofacial” OR “Surgery Oral” OR “Oral Surgery” OR “Oral Surgeries” OR “Maxillofacial Surgery” OR Surgery) AND Orthodontic* AND (Laser* OR “Laser Therapy”))	#1 MeSH descriptor: [Oral Surgical Procedures] explode all trees 4354 #2 “Procedure Maxillofacial” 0 #3 MeSH descriptor: [Surgery, Oral] explode all trees 171 #4 (Oral Surger* OR “Maxillofacial Surgery” OR Surgery) 226774 #5 #1 OR #2 OR #3 OR #4 227673 #6 MeSH descriptor: [Orthodontics] explode all trees 2533 #7 Orthodontic* 4442 #8 #6 OR #7 5225 #9 MeSH descriptor: [Lasers] explode all trees 2051 #10 MeSH descriptor: [Laser Therapy] explode all trees 3983 #11 Laser* 19156 #12 #9 OR #10 OR #11 19210 #13 #5 AND #8 AND #12 91

all of the RoB assessments can be seen in the supplementary table.

Results of Individual Studies and Syntheses

Summary statistics for results on each outcome of the individual studies are presented in Table 2. Because of the clinical/methodological heterogeneity among the studies, differences in the way of reporting results and/or missing data, it was not possible to perform meta-analyses.

Three studies evaluated gingivectomy in orthodontic patients.[4,17,18] Lione et al.[4] evaluated participants at baseline and 1, 3, and 6 months after the procedures, whereas Sobouti et al.[17] and Ize-Iyamu et al.[18] evaluated participants only immediately after the procedures. PPD, CCL, and GI were only evaluated by one study[4] that showed that no statistically significant differences were observed between groups for these outcomes at any follow-up period. Studies from Sobouti et al.[17] and Ize-Iyamu et al.[18] evaluated PA and BA, but the latter performed different types of procedures beside gingivectomy, and the results were pooled together in the outcomes. For Sobouti et al.,[17] PA and BA were statistically significantly lower in the intervention group (IG) when compared with the control group (CG).

The only surgical procedure that was evaluated by different studies with the same outcomes (PPD, CCL, RR, and PA) and with the same evaluation periods (baseline and 2 months) was CSF.[19,20] Regarding PPD and CCL, there was no statistically significant difference between laser and scalpel for both studies.[19,20] Regarding RR, there were no statistically significant differences in the degrees of relapse among laser and scalpel interventions for both studies, although the laser intervention in Miresmæili et al.[20] showed less relapse than in Jahanbin et al.[19] With respect to PA, Miresmæili et al.[20] showed no statistically significant differences between IG and CG, whereas Jahanbin et al.[19] showed statistically significantly less pain in IG compared with CG. Pain intensity was not severe in any group.

Ize-Iyamu et al.[18] performed gingivectomy, exposure of impacted teeth with laser and scalpel, maxillary buccal frenectomies, and operculectomies. The results were pooled together, so distinction between the procedures could not be performed. PA and BA were statistically significantly lower in IG when compared with CG.

The certainty of evidence was moderate for the PPD, CCL, and GI outcomes when comparing the use of laser and scalpel for gingivectomy because of the small number of participants evaluated. The evidence related to the PPD, CCL, and RR outcomes for CSF was also seriously affected by the insufficient number of patients studied and additionally by the RoB. Thus, the certainty of evidence was low for these syntheses. Concerning the PA and BA outcomes, regardless of the procedure performed, the certainty of evidence was very seriously affected by the RoB and seriously affected by the small number of participants evaluated. In addition, the results for the PA outcome were inconsistent for the CSF procedure. Therefore, the overall certainty of evidence was very low for PA and BA outcomes.

DISCUSSION

In orthodontics, the use of surgical lasers has increased because of advantages such as higher precision,[21] coagulation of blood vessels,[22] and less need for sutures.[23] This review assessed the existing literature on these issues using methodological rigor and well-established criteria.

Table 1. Extended

LILACS and BBO	EMBASE	Gray Literature
((mh: "Oral Surgical Procedures" OR "Procedimentos Cirúrgicos Bucais" OR "Procedure Maxillofacial" OR "Maxilofacial Procedimento" OR mh: "Surgery, Oral" OR "Cirurgia Bucal" OR oral surger* OR "Cirurgias Bucais" OR "Maxillofacial Surgery" OR "Cirurgia Maxilofacial" OR surgery OR cirurgia) AND (mh: orthodontics OR ortodontia OR orthodontic* OR ortodonti*) AND (mh: lasers OR mh: "Laser Therapy" OR "Terapia a Laser" OR laser*)) AND (db:("LILACS" OR "BBO"))	('oral surgical procedure':ti,ab,kw OR 'oral surgical procedures':ti,ab,kw OR 'procedure maxillofacial':ti,ab,kw OR 'surgery oral':ti,ab,kw OR 'oral surgery':ti,ab,kw OR 'oral surgeries':ti,ab,kw OR 'maxillofacial surgery':ti,ab,kw OR surgery:ti,ab,kw) AND orthodontic*:ti,ab,kw AND (laser*:ti,ab,kw OR 'laser therapy':ti,ab,kw)	Surgery, Oral AND Laser AND Orthodontic*

Only three studies evaluated gingivectomy in orthodontic patients.[4,17,18] However, there was lack of standardization among the studies. The laser protocols were different as well as the outcomes assessed. Only Lione et al.[4] evaluated PPD, CCL, and GI when performing gingivectomies. Sobouti et al.[17] and Ize-Iyamu et al.[18] evaluated PA and BA for this type of surgery. Ize-Iyamu et al.,[18] on the other hand,

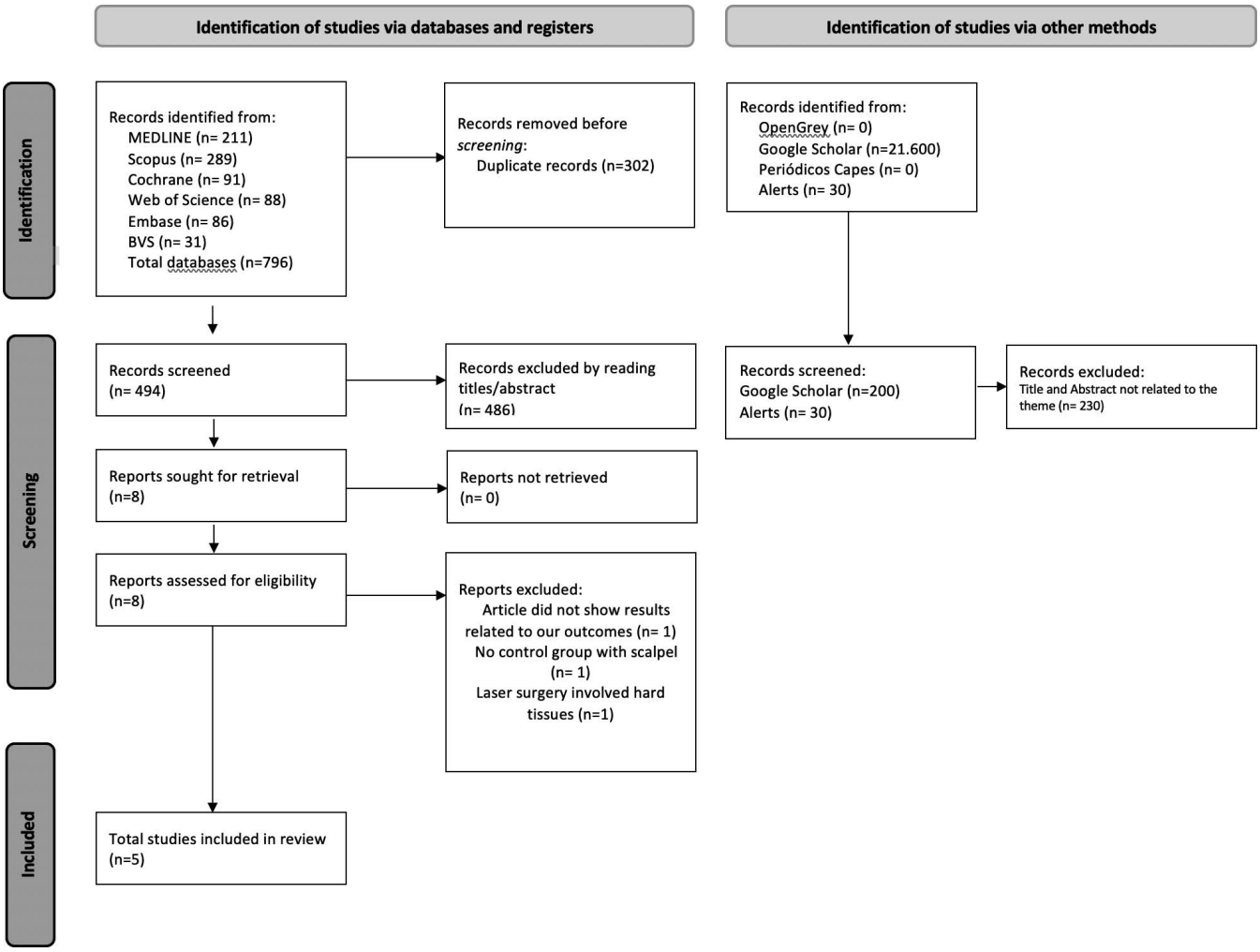

Figure 1. PRISMA flow diagram for the study selection procedure.

Table 2. Summary of Characteristics of the Included Studies

		Participant-Related Information	
Author, Year, and Country	Study Design	Sample Size, IGs and CGs (Male/Female)	Sample Age, Years, IGs and CGs
Lione et al. 2020, Italy[4]	Randomized clinical trial	IG: 19 (9/10) CG: 19 (11/8)[a]	14.4 ± 1.9 (range, 11.7–19.8)
Miresmæili et al. 2019, Iran[20]	Randomized clinical trial	IG: 15 (5/10) CG: 15 (5/10)[d]	IG: 21.33 ± 4.54 CG: 20.21 ± 2.86
Sobouti et al. 2014, Iran[17]	Randomized clinical trial	IG: 15 (5/10) CG: 15 (7/8)	IG: males, 20.3 ± 3.4; females, 21.9 ± 3.3 CG: males, 21.3 ± 3.6; females, 21.3 ± 3.4
Jahanbin et al. 2014, Iran[19]	Randomized clinical trial	IG: 6 CG: 6[f]	24.5 ± 5.1 (range, 16–32)
Ize-Iyamu et al. 2013, Nigeria[18]	Randomized Clinical Trial	IG: 12 CG: 11 (6/17)	Range, 10–30

[a] One patient in the intervention group was excluded because the bone crest was revealed at the same level of the cemento-enamel junction (CEJ) during transgingival probing. During the follow-up, there was one drop-out in the control group.
[b] GI: 0 = absence of inflammation, 1 = mild inflammation, 2 = moderate inflammation, 3 = severe inflammation.
[c] Outcomes not evaluated by studies.
[d] One patient from the intervention group was excluded because of noncompliance.
[e] BA: 0 = no bleeding, 1 = bleeding under the skin and petechial class, 2 = mild bleeding, 3 = gross bleeding, 4 = mortal bleeding or annoying bleeding.
[f] A total of 24 subjects satisfied the inclusion criteria and agreed to participate in the study: 20 females and 4 males who ranged in age from 16 to 32 years (mean age, 24.5 ± 5.1 years), who were divided into four groups.

performed different procedures rather than gingivectomy (ie, maxillary buccal frenectomies, surgical exposure of impacted teeth, and operculectomies). Because the results were not stratified according to the procedures for this last study, it was not possible to know the specific differences between laser and scalpel for each intervention or to use these data for a meta-analysis.

Only Lione et al.[4] evaluated PPD, CCL, and GI when performing gingivectomies. The first two outcomes were evaluated in millimeters, whereas the latter was evaluated by a scale ranging from 0 to 3, where 0 was an absence of inflammation and 3 was severe inflammation. The study demonstrated that both laser and scalpel led to a substantial reduction of PPD and a substantial increase of CCL when compared with the

Table 2. Extended

	Intervention-Related Information		
Type of Surgery	Laser (Type and Procedure Details)	Scalpel (Type and Procedure Details)	Outcome Assessed
Gingivectomy	Anesthesia with 2% lidocaine and 1:80,000 adrenaline Diode laser (810 nm FOX III; Sweden & Martina, Due Carrare, Padova, Italy), 300-μm disposable tip, setting of 1–1.5 W in continuous mode Acetaminophen to control postoperative pain if necessary	Anesthesia with 2% lidocaine and 1:80,000 adrenaline External bevel incision performed by using a scalpel blade (#15c) Acetaminophen to control their postoperative pain if necessary	PPD, mm (mean ± standard deviation) CCL, mm (mean ± standard deviation) GI, 0–3 (mean ± standard deviation)[b]
Circumferential supracrestal fiberotomy	Anesthesia with 2% lidocaine with 1:100,000 epinephrine Er,Cr:YSGG laser inserted into the gingival sulcus (Waterlase, Biolase, Irvine, Calif): wavelength of 2780 nm, power of 1.5 W, frequency of 30 Hz, water spray of 40% and air spray of 20%; GOLD handpiece with a 9 × 0.5-mm MZ5 tip	Anesthesia with 2% lidocaine with 1:100,000 epinephrine Surgical blade (#11) inserted into the gingival sulcus at an angle of 10–15° and moved around the tooth so that all the fibers were severed	PPD, mm (mean ± standard deviation) CCL, mm (mean ± standard deviation) RR, degrees (mean ± standard deviation) PA, 0–10 (mean)
Gingivectomy	Topical application of TAC 20 gel (20% lidocaine, 4% articaine, 2% phenylephrine) Anesthesia with 2% lidocaine plus 1:100,000 epinephrine (in case of pain) Diode laser (diode Epic, BioLase), λ = 940 nm, with a 400-μm fiber at 0.9-W power used to trim and form the gingival margin	Topical application of TAC 20 gel (20% lidocaine, 4% articaine, 2% phenylephrine) Anesthesia with 2% lidocaine plus 1:100,000 epinephrine (in case of pain) Scalpel (#15c) used to trim and form the gingival margin 11 patients needed suturing	PA, 0–10 (mean) BA, 0–4 (mean)[e]
Circumferential supracrestal fiberotomy	Anesthesia with 2% lidocaine with 1:100,000 epinephrine Er:YAG laser (Smart 2940D; Deka Laser, Florence, Italy) with wavelength of 2940 nm, 100 mJ of energy, pulse repetition rate of 10 Hz, and air and water spray inserted intrasulcularly at an angle of 10–15° Archwire retained for 1 month after surgery to allow reattachment of the gingival and periodontal fibers	Anesthesia with 2% lidocaine with 1:100,000 epinephrine Surgical blade (#11) inserted into the gingival sulcus up to the level of the alveolar crest Blade moved around the tooth circumference to sever the free gingival and transseptal fibers Archwire retained for 1 month after surgery to allow reattachment of the gingival and periodontal fibers	PPD, mm (mean ± standard deviation) CCL, mm (mean ± standard deviation) RR, degrees (mean ± standard deviation) PA, 0–10 (mean ± standard deviation)
Maxillary buccal frenectomies, gingivectomy, surgical exposure impacted teeth, and operculectomies	Diode laser (wavelength 810 nm)	Surgical blade (#15C) and black silk sutures used for all cases requiring suturing	PA, 0–10 (frequency) BA, 0–4 (frequency)

baseline measurements, with no statistical differences between the groups. Laser-assisted gingivectomies seem promising for orthodontic patients considering that the results were similar to conventional surgeries and that the conventional treatment using scalpels can lead to clinical complications such as bleeding.[24] Although the study presented low RoB for the mentioned outcomes, because there was no other study for comparison of the results, more studies with methodological similarities are necessary. Also, larger samples are needed to obtain powerful results and to provide higher certainty of evidence.[25]

Sobouti et al.[17] and Ize-Iyamu et al.[18] assessed PA and BA regarding gingivectomies. Unfortunately, the study by Ize-Iyamu et al.[18] did not provide separate results for each procedure performed. For this reason, the results of this study were not combined with those of Sobouti et al.[17] Pain was evaluated in all studies using a visual analog scale ranging from 0 to 10, where 0 was no pain and 10 was intolerable pain. Pain was assessed by the patients themselves. The fact that they were aware of the procedures performed may have interfered in how they reported symptoms and their intensity.[26] This characterizes the main methodological limitation of the studies for this outcome. This fact, added to the limited amount of data assessed, resulted in a very low certainty of evidence. Regarding BA, this outcome was evaluated on a scale from 0 to 4, where 0 was no bleeding and 4 was mortal bleeding. The outcome assessors were aware of the intervention

Table 2. Extended

Outcome-Related Information							
		Results, IGs and CGs					
Evaluation Periods	Group	PPD	CCL	GI	RR	PA	BA
Baseline	IG	4.8 ± 1.0 (4.3–5.2)	7.7 ± 0.8 (7.4–8.1)	0.3 ± 0.2 (0.2–0.4)	–[c]	–	–
	CG	4.9 ± 1.1 (4.4–5.4)	7.9 ± 0.8 (7.6–8.3)	0.3 ± 0.2 (0.2–0.4)	–	–	–
1 month	IG	1.8 ± 0.4 (1.6–2.0)	10.1 ± 0.8 (9.7–10.5)	0.5 ± 0.2 (0.3–0.7)	–	–	–
	CG	1.8 ± 0.4 (1.7–2.0)	9.9 ± 0.7 (9.5–10.2)	0.5 ± 0.2 (0.3–0.7)	–	–	–
3 months	IG	2.5 ± 0.6 (2.2–2.7)	9.0 ± 0.6 (8.7–9.3)	0.6 ± 0.2 (0.4–0.8)	–	–	–
	CG	2.6 ± 0.6 (2.3–2.9)	8.9 ± 0.6 (8.6–9.2)	0.6 ± 0.3 (0.3–0.9)	–	–	–
6 months	IG	2.7 ± 0.5 (2.5–3.0)	8.6 ± 0.6 (8.4–9.0)	0.7 ± 0.3 (0.4–1.0)	–	–	–
	CG	2.9 ± 0.4 (2.7–3.1)	8.6 ± 0.7 (8.3–8.9)	0.7 ± 0.2 (0.5–0.9)	–	–	–
Baseline	IG	1.44 ± 0.30	–	–	–	2.2	–
	CG	1.41 ± 0.29	–	–	–	0.86	–
2 months	IG	1.65 ± 0.34	4.87 ± 2.08	–	4.87 ± 2.08	–	–
	CG	1.55 ± 0.31	5.09 ± 1.59	–	5.09 ± 1.59	–	–
Postsurgery	IG	–	–	–	–	0	0.36
	CG	–	–	–	–	5.2	1.15
Baseline	IG	1.68 ± 0.44	9.27 ± 1.49	–	–	1.97 ± 0.72	–
	CG	1.89 ± 0.32	9.46 ± 1.22	–	–	4.04 ± 1.12	–
2 months	IG	2.04 ± 0.50	9.73 ± 1.56	–	6.12 ± 1.77	–	–
		2.07 ± 0.29	9.69 ± 1.49	–	4.24 ± 1.12	–	–
	CG						
Postsurgery	IG	–	–	–	–	83.3% (10 patients): 0	0
	CG	–	–	–	–	27.2% (3 patients): 8	1

received, and calibration could not be performed. In a similar way as PA, this methodological limitation, as well as the limited amount of data evaluated, led to a very low certainty of the evidence.

Although different procedures were pooled together by Ize-Iyamu et al.,[18] the methodology to avoid bias when intervening in hard tissues (ie, exposing impacted teeth) was accurate. All patients initially underwent a previous surgical procedure to raise a flap and remove the overlying bone with a surgical bur. Then, an orthodontic bracket was bonded to the impacted tooth and the flap was replaced. Two months later, patients were randomly assigned into two groups and the exposures were performed methodologically similar between the groups, differing only by the scalpel or the laser used in the surgery. Therefore, both interventions could be compared. However, because the study did not provide separate results for each procedure performed, PA and BA could not be compared with other studies. The evidence related to the outcomes from this study was also very seriously affected by the RoB as well as by the limited amount of data evaluated. Despite the aforementioned limitations, the evidence showed that, regardless of the procedure performed and the laser protocol, there was a trend in favor of laser surgery in reducing pain and bleeding (with very low certainty of the evidence).

Two studies performed CSF in orthodontic patients.[19,20] This surgical procedure was evaluated with the same outcomes (PPD, CCL, RR, and PA) and for

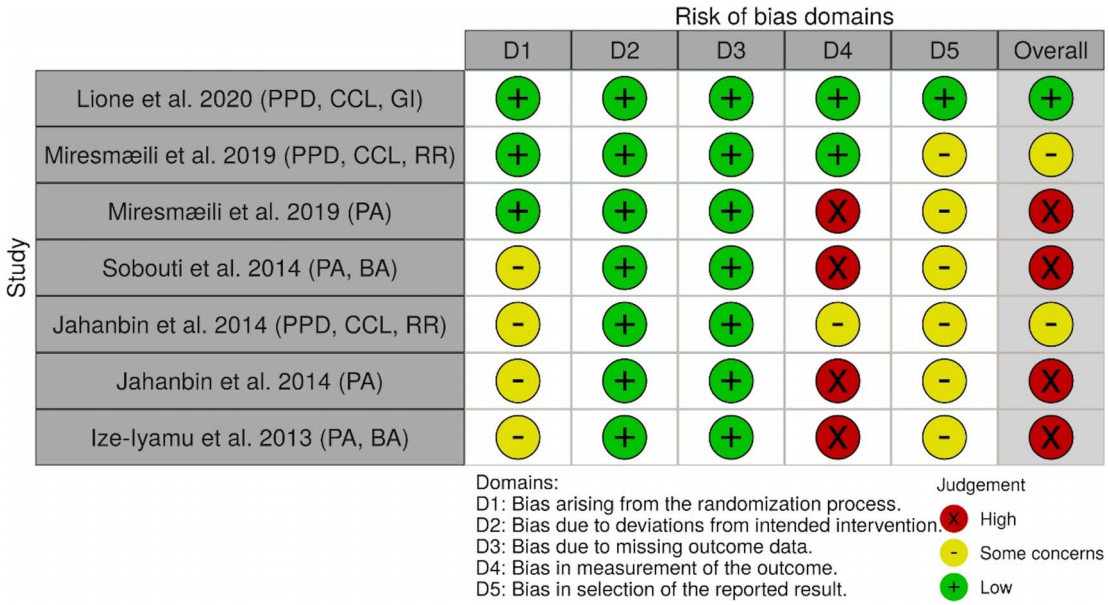

Figure 2. RoB assessment for the included randomized studies according to Cochrane's Collaborations' tool.

the same evaluation periods (baseline and 2 months) by both studies. Despite CSF being different from gingivectomy, the results for PPD and CCL also demonstrated that no statistical difference was found between laser and scalpel. RR was measured in degrees comparing the difference between the rotation of incisors immediately and 2 months after the CSF was performed. With low overall certainty of evidence, both studies[19,20] found no statistical difference between the interventions, but differences in the amount of RR was found between the studies. One reason for the discrepancy may have been the difference between sample sizes because Miresmæili et al.[20] performed a sample size calculation and Jahanbin et al.[19] did not. Miresmæili et al. had 31 patients[20] and Jahanbin et al. had 12 patients.[25] Also, the use of different types of lasers and laser wavelengths could have been related to the difference between the results, which reinforces the need of standardization between studies. Regarding PA in CSF, Jahanbin et al.[19] showed that there was less pain in the IG compared with the CG in contrast to Miresmæili et al.[20] The variations in the results of PA between the studies could also have been attributed to differences in sample sizes (Jahanbin et al.[19] did not calculate the sample size and probably provided unpowered results) and the laser protocols used. In addition, because pain is subjective and was reported by patients themselves, there was a possibility of self-report bias and placebo effect by the use of a high-quality tool, that is, a surgical laser.[27] Mainly because of these limitations, the studies were judged as having high RoB. These facts, in addition to the inconsistency of the provided results as well as the limited amount of data assessed, resulted in a very low certainty of evidence.[19,20]

Due to the small number of studies evaluating the same procedure, the same outcomes, and the same evaluation periods, no meta-analyses could be performed. In addition, there was methodological heterogeneity mainly related to protocols in the use of a laser. Different types of lasers, ranging from 810 to 2940 nm, were selected under the same category, which could have led to different results because different laser lengths are absorbed differently by different body tissues.[28] Future research should focus on performing similar types of surgery, using larger sample sizes, following patients for standardized periods, and using comparable laser protocols. In addition, regarding the RR for CSF, it is necessary to follow the participants for longer periods of evaluation because this is an outcome that can be expressed in the long term.[19]

CONCLUSIONS

- The existing literature on the subject is scarce, very heterogeneous, and has methodological limitations. Based on the available evidence, it is not possible to draw definitive conclusions about the beneficial effect of laser use in orthodontic patients.
- Researchers are encouraged to conduct new studies in the future, preferably randomized clinical trials, with standardized interventions and follow-up periods.

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SUPPLEMENTAL DATA

Supplemental Table 1 is available online.

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